Creating a Robust Market for Residential Energy Management through an Open Energy Management Architecture

For External Distribution

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Abstract

A new framework for public policy is needed to advance the adoption of residential energy management. Policies that allow and encourage innovative new solutions and stimulate new markets for residential energy management are largely missing from state and federal Smart Grid strategies. Without an open market for residential energy management, there will be minimal private investment and new product development, leaving the promise of a ubiquitous national Smart Grid unrealized. In order for entrepreneurs to bring innovative, cost-effective products and services to the consumer market, state and federal policies must be adopted that provide a level "playing field" for all players, including third-party Energy Management Service Providers. This can only be achieved if utilities provide electronic access to usage and pricing data in real time, and state and federal policies allow and embrace a diverse ecosystem of home network and energy management technologies to compete for consumers' pocketbooks.

1 Public policy and the residential energy management market

The United States has embarked on upgrading the electric utility industry to a Smart Grid. The Smart Grid for electricity integrates subsystems for generation, transmission, and distribution to improve the reliability and efficiency of electricity supply. The Smart Grid also accommodates distributed energy generation, such as solar and wind, and electric vehicles. A stated policy goal of the Smart Grid is to enable all these subsystems to interoperate using information technology[1].

Over the last decade, dramatic advances in information technology have benefited just about every aspect of our economy and society. It is widely accepted that modernization of the electric grid can be achieved using the same technologies. The following are key public policy principles necessary to achieve a sustainable market for residential energy management solutions and services.

A. The need for an Open Energy Management Architecture (OEMA)

This paper presents a fundamental set of policy principles needed to achieve a robust consumer market for energy management. This is the best way to achieve national Smart Grid residential energy management objectives such as peak load demand response. A competitive market for energy management services will minimize the need for capital expenditures by utilities in order to meet these objectives. An architecture is introduced herein that embodies these principles, the *Open Energy Management Architecture* (OEMA).

By allowing an open architecture and an open market, the federal government will encourage new and innovative solutions to be brought to market. By adopting these principles, policymakers will recognize that a consumer market open to all residential energy management solutions is needed to achieve widespread energy management by consumers. We believe such an architecture should be considered in addition to the utility-based AMI architectures currently being proposed.

OEMA is a model for accomplishing effective energy management independent of the utility's deployment of Advanced Metering Infrastructure and smart meters. The only requirement of the utility is to publish pricing information and Demand Response requests, and provide direct access to real time meter data. Direct load control (i.e.

[1] Papers about interoperability and the smart grid are available from the GridWise Architecture Council at www.gridwiseac.org and at NIST at www.nist.gov/smartgrid.

utilities shutting off devices) is not required. Distributed load control can achieve the same objectives without forcing unwanted actions on the consumer.

In the OEMA, any entity, including the utility or third-party providers, may provide energy management services, defined here as an Energy Management Service Provider. Examples of such third-party providers are cable operators, telephone companies, electricity retailers, Internet service providers, and others who choose to support such services. This is already creating a whole new class of companies dedicated to energy management and related home automation services.

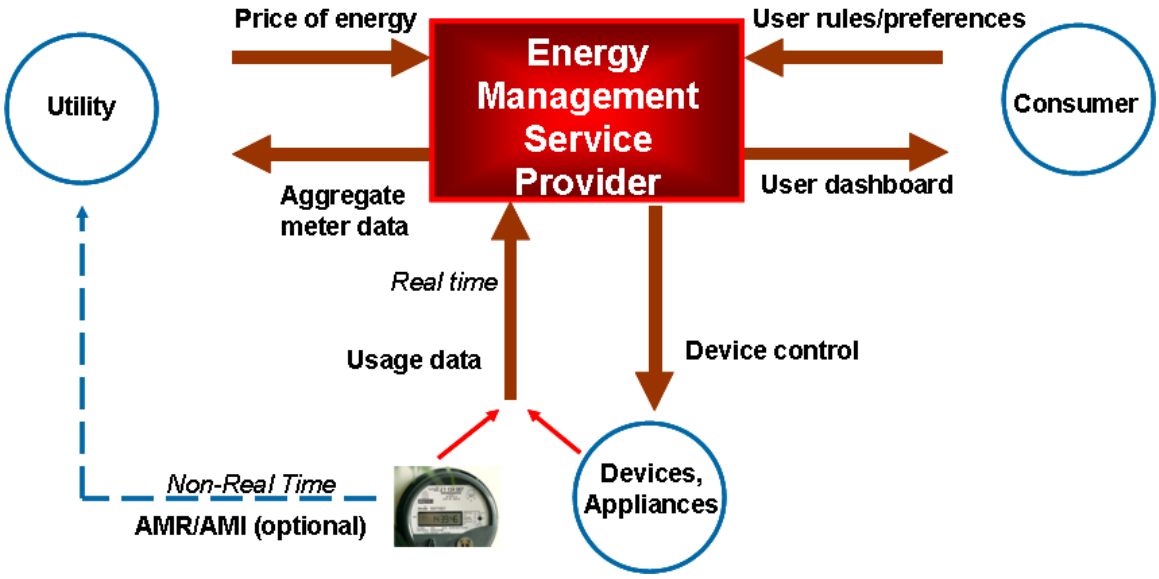

Figure 1 – The Role of EMSP

EMSP functions include configuring, provisioning, managing and controlling the various sensors and devices within the home. These functions are delivered from servers that manage the applications and the communications network, and provide differentiating features, such as cross-platform features (e.g., sharing data between the home security system and the energy management system) and Quality-of-Service (QoS) levels.

B. The need for separation of policy domains

Public policies applied to the Smart Grid should be very different from the policies applied to the Smart Home.[2] Smart Grid policies should focus on creating a robust

[2] The Smart Home, as referred to in this paper, is defined broadly as a residential unit that employs home automation, ranging from a simple programmable thermostat to an on-line, whole-home security, monitoring, and automation system.

electric ***grid***, whereas Smart Home policies should focus on creating a robust ***market***. Market-shaping policies are needed that allow, even encourage, the adoption of Smart Home energy management products and services. Without these, large scale adoption of energy management by consumers may not be achieved.

Public policies at the federal and state levels have been instituted to accelerate meeting the stated goal of achieving interoperability in the Smart Grid. The National Institute of Standards and Technology (NIST) has the mandate under the Energy Security and Independence Act of 2007 to select interoperable standards for the Smart Grid. However, the scope of some of the proposed standards is too broad as they extend beyond the grid into the home. Many of the standards being considered do not recognize that residential energy management is a rapidly developing area, and it is impossible to predict today what products and services will prevail in the marketplace.

It is increasingly clear that public policy needs to treat the consumer domain separately. While the Smart Grid must be under the control of the utility, the Smart Home must be under the control of the consumer. In order to connect consumer-chosen solutions to the Smart Grid, a set of standard, published interfaces should be adopted by NIST to provide the energy management system with a way to receive usage, pricing information and demand response controls. In the home, however, mandated standards should not be imposed beyond the meter, which defines the demarcation point between the utility's domain and the consumer's domain. More to the point, the currently contemplated Smart Grid models for energy management, including the NIST Interoperability Roadmap, should not be based on exclusive utility control of the devices in the home.

Also, selecting standards for the home is unnecessary and even unwise because Smart Home technology is rapidly evolving. Selecting standards for a home network and home appliances will stifle competition that could otherwise result in a rich variety of technology solutions for energy management.

Therefore, public policy should be separated into the following domains, as shown in Figure 2:

- The Utility Domain (Smart Grid domain),
- The Consumer Domain (Smart Home domain), and
- The Energy Management Service Provider Domain (EMSP Domain)

We believe it is necessary to have three sets of public policies that recognize the different goals and establish clear boundaries among the three domains.

Different sets of public policies are needed due to the dramatically different objectives and environments in each domain. In the consumer domain, a flourishing, national marketplace for residential energy management services should be allowed, even encouraged. The objective should be to encourage and facilitate open competition and choice for consumers, rather than restricting consumers to the capabilities of the local electric utility.

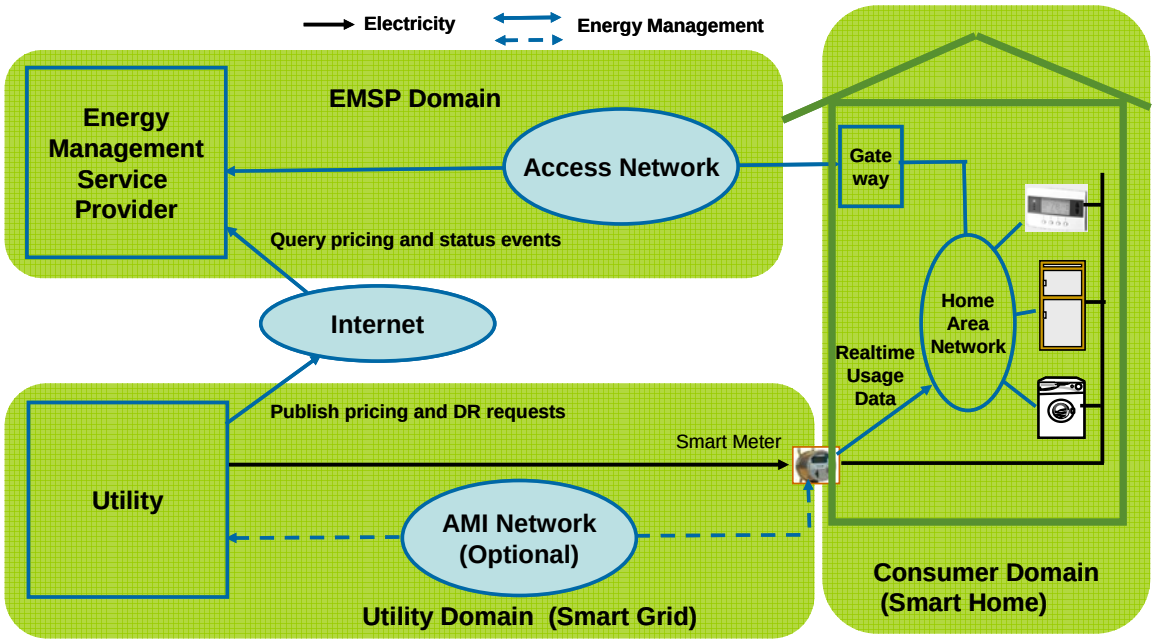

Figure 2 – OEMA Defines Three Domains for Public Policy

In contrast, it is clear that the actual electric grid infrastructure up to the meter (the Utility domain) for transmission and distribution (T&D) should be based on very specific, narrowly constrained standards, because the T&D network is critical for national energy security.

I. The Utility Domain

In the OEMA model, the Utility Domain delivers electricity to the home and is only concerned with maintaining an adequate supply of electricity to the home. The utility domain ends at a clear service demarcation point – the electrical meter. The management of electricity usage beyond the meter, i.e., the demand for electricity, is left to the consumer.

Key Principles

1. Utility involvement with the Smart Grid should only be concerned with managing the supply of electricity to the service interface at the home, typically the meter, and management of this electricity supply should not extend by default into the home. Public policy should not by default give a monopoly for energy management services to utilities. All parties should have to compete on the same terms for the opportunity to provide energy management services to the consumer.

2. Utility interfaces for DR must be designed with minimal constraints on consumer choice of energy management services, home networks, and consumer products.

3. There are many network options available today for utilities to transport meter data and other energy management information. If utilities choose to offer their own energy management services, in competition with other EMSPs, utilities should be encouraged, if not required, to solicit competitive bids for network connectivity from all network providers. Existing communications access networks such as telco, cable, and cellular can be used for meter reading, DR, and energy management.

II. The Consumer Domain

Key Principles

1. Consumer behavior changes are much better achieved by incentives, not deterrents. U.S. policy could provide such incentives directly to consumers. Vouchers or tax credits or utility rebates for energy management solutions and services can begin to create a competitive market for energy management without forcing specific solutions onto consumers.

2. Utility control of customer premises equipment must be on an opt-in, voluntary basis, and should not be imposed with mandates or severe penalties for not participating. The consumer has the right to establish any set of preferences for the use of electricity and their appliances. The consumer must be allowed to override any delegated control of their devices in real time or through pre-programmed preferences. Consumers must explicitly agree in advance and opt-in to any DR actions taken by the utility. The consumer has the authority and responsibility for device-level management within the home.

3. The consumer owns the usage data about household energy consumption. Therefore, consumers need electronic access to meter data in real time via a standard interface. This interface, possibly based on wireless technology, should be adopted by all utilities nationally.

4. There should be also be a nationally mandated requirement for utilities to provide pricing and pricing signals electronically using a published Applications Programming Interface (API) on the public Internet. Also, a wide spectrum of methods for disseminating utility pricing and pricing signals should be required, ranging from newspaper, radio, television, outbound phone calls, text messages, emails, and websites. This way, consumers of all types will have the flexibility to use the method of their choosing to track energy pricing.

5. Consumers should be able to employ any means and tools to manage energy, as long as they do not harm the grid.

6. Policies should not obsolete existing working Smart Home systems. Any and all systems should be allowed to connect to the Smart Grid, as long as they do not harm the grid.

7. Policies should allow all types of communications networks and protocols to be used within the consumer domain. Interoperability should be achieved at the applications layer, not the network layer or below. Existing in-home networks such as Wi-Fi, Ethernet, and Home Area Networks (ZigBee, Z-Wave, HomePlug, etc.) should be leveraged to support Smart Grid applications such as meter reading, DR, and energy management.

8. The basis for the Smart Home to Smart Grid communications interface should be IP (Internet Protocol) since it is the common protocol for Smart Homes. The interface should accommodate IP-enabled and non-IP-enabled devices. Non-IP-enabled devices would be supported through an IP proxy.

9. The consumer may assign data ownership rights and device control to a third party, such as an energy management service provider of their own choosing. Consumers should have the option to purchase energy management products independently, or to contract with third parties, such as EMSPs, without participation or approval of the utility.

III. The EMSP Domain

Key Principles

1. Public policy should encourage entrepreneurship in the consumer domain (new company formation and new investment). Federal funding and subsidies for development of innovative new home-based technologies should be provided independent of Smart Grid funding at the federal or state level.

2. Policy should not preclude the entry of new players and technologies into the consumer domain.

3. Policy should foster an open, competitive market for energy management products and services that embraces competition among utilities, communications companies, new service providers, consumer product manufacturers, and consumer electronics companies in the enablement of energy management capabilities.

4. Policy should encourage entrepreneurs to develop smart grid products and services for the consumer domain, with mechanisms to mitigate development risks, such as R&D tax credits.

5. Policy should allow a competitive EMSP market with a level playing field for utilities and third parties alike.

6. Policy should allow competitive distribution channels for energy management products and services.

7. Policy should limit government standards setting to only the minimum set of interfaces required for the consumer domain to query the utility domain for pricing signals and real time meter data.

8. EMSPs must protect consumer data as private customer-owned data and use these data only to deliver the contracted services. EMSPs should not archive personally identifiable data not needed for service delivery.

9. Standards that are selected for interoperability between the grid and home should specify interfaces at the application layer, so that the Smart Grid can accommodate the widest variety of access and home networks, including those yet to be defined.

C. The need for market-driven outcomes

The best outcome for the consumer would be an open market that does not mandate a specific utility solution for energy management. The market is the best judge of the effectiveness of technologies. In fact, the international standards bodies ISO and IEC recently adopted the principle of market acceptance in judging information technology standards. Open-market solutions can meet all consumers' and utilities' needs without being tailored to each utility. Such solutions would create national markets for innovators, rather than regional or locally fragmented markets based on a specific local utility. An open market would preclude a utility from acting as a gatekeeper for third-party providers of energy management.

Robust markets have long been the model for America's economic growth. Entrepreneurism is the creative engine of these robust markets. The will of the country to solve climate change and energy dependency problems can be directed toward creating innovative marketplace solutions, as long as market barriers are removed and incentives are created. The emerging Smart Grid policies must be adjusted to remove potential barriers that prevent private investment in the technological revolution occurring in the Smart Home.

Public policies must allow the Smart Home to evolve independently of the Smart Grid.To underscore the need, recent market research suggests residential energy management system adoption will outpace utility Advanced Metering Infrastructure (AMI) and smart meter deployments. This begs the question: how will these standalone residential energy management systems talk to the grid?

D. The need for access to real-time usage and pricing data

Residential energy management systems and Energy Management Service Providers (EMSPs) can deliver energy management solutions that meet all the stated goals of the smart grid, *as long as utilities provide access to real-time meter data, and access to pricing signals.* If these data are provided in a standard format, solutions can be developed and deployed independent of the utilities' plans and schedules for AMI and smart meter deployment.

Many behavioral studies have shown that immediate feedback is required for consumers to engage in energy reduction activities. Consumer energy "dashboards" must have access to real time usage information. Though there are aftermarket solutions and workarounds to measure energy use, these solutions add significant cost to a function that already exists in the meter.

This requires the ability to read the meter directly in a standard way in real time. Secondly, it requires the utility to publish pricing and demand response requests in a standard format on the Internet so these data can be queried.

The most basic requirement of OEMA as applied to energy management is shown in Figure 3. Smart Homes should be able to interact with the Smart Grid, independent of any utility constraints. Smart Homes can make independent decisions based on usage, pricing, and DR requests. Centralized demand response and direct load control are not required.

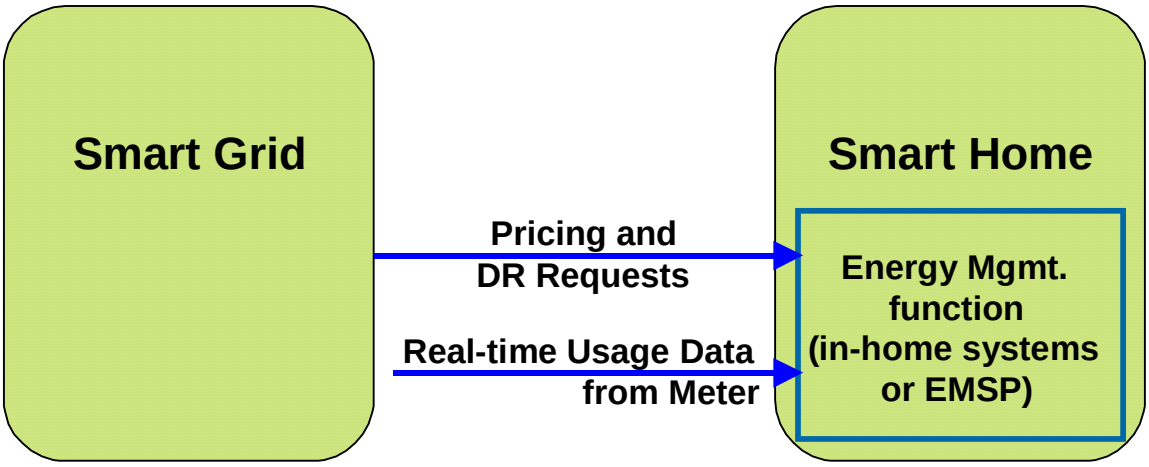

Figure 3 – Two key interfaces required to connect Smart Homes to the Smart Grid

E. The need for distributed Demand Response solutions

Demand Response (DR) is an important element in the concept of energy management, and long used as the justification for utility investments in an AMI network. The goal of DR is to reduce demand during periods of peak usage. Utilities have planned to do this in a centralized manner, by sending commands to devices in the home, such as to raise the thermostat set point or disable the air conditioner compressor.

We believe a better alternative is to perform DR in a distributed manner, where the endpoints of electricity consumption monitor the status of the grid, and respond appropriately. The utility industry's model for DR is based on extending the Smart Grid to end devices on customer premises to control them directly (centralized control), whereas the information technology (IT) industry model for DR is based on allowing consumers to adjust their consumption of electricity autonomously by continuously tracking conditions (distributed control).

F. The need for a win-win for utilities and consumers

Energy management, clearly, must serve the needs of both consumers and the utility. We believe it is a win-win for utilities and for consumers to control demand by changing price signals or issuing status changes on the web. Utilities would not need to invest in separate networks and systems to achieve DR. By opening pricing and usage data to consumers, the consumers' energy management systems can perform all the necessary energy management functions, and at a far lower cost. A large competitive market can benefit consumers and the utility industry alike by creating economies of scale on a national basis.

G. The need for consumer involvement

Effective energy management requires that consumers participate in the process of controlling energy usage. Consumers need incentives to participate willingly in a solution for energy management. If consumers are not given the tools that empower them to easily manage energy consumption, confusion and backlash will ensue. This is already being seen in various smart meter deployments where bills have increased, and consumers have initiated class action lawsuits claiming that the Smart Grid was forced upon them. Simple, easy-to-use products and services that give the consumer choice and control are a must. At the same time, these products and services must interoperate. Market-driven standards provide the best solutions for the consumer; therefore, regulators need to allow innovation through competition among standards and technologies in the home.

H. The need for flexible solutions

Consumers have varying objectives, budgets, and preferences. Some consumers may have broader goals than complying with supply limitations, such as energy conservation, even when power supplies are not strained. Others may want to have a portable solution that can take with them when they move. Therefore, it is essential that a robust market for energy management offer choices that appeal to a wide range of consumers and utility demand response programs.

2 Benefits of an Open Energy Management Architecture

The key differentiation between energy management currently offered by some public utilities and the services enabled by the OEMA is choice, control, and convenience. The OEMA can support a competitive market for energy management and related home services from multiple suppliers. Energy management delivery via OEMA would not be limited to communications networks specified by the public utility for access to homes or within homes. Consumers will have the final say in how their energy usage is managed.

If the public utility were to become the sole supplier of energy management services, there would be less competition and less innovation in energy management. The OEMA model also provides benefits to the utility. The utility does not have to incur costs to build out their own EMSP capability, because an open market for energy management services will provide such capabilities. Thus, the OEMA will benefit both providers and consumers of electricity. Consumer will take more ownership and responsibility for maintaining and using the systems on a daily basis.

Achieving practical energy management that saves money for consumers without undue inconvenience is complicated. Consumers have little patience for training or learning how to understand and operate complicated devices. Therefore, an important factor in the success of any EMSP will be to provide tools and services that assist consumers in compelling, engaging, and easy-to-use ways. By participating in an open market, new entrants will assure that innovation continues to flourish.

3 The CableLabs® Home Security, Monitoring, and Automation Specification

Service providers, such as cable operators and telcos, have concluded they must deploy a common platform for all home automation, including energy management, in order to justify the investment. This shares platform costs across all managed home services, and enables new features. For example, the security system might inform the energy management system that someone just arrived home. These kinds of innovative cross-

platform features, and the open-ended "long tail" of future applications, reinforce the business case for home automation.

In recognition of the growing need for a common architecture for home automation, CableLabs created the SMA (CableLabs Home Security, Monitoring, and Automation) interface specification. Developed in collaboration with home automation companies, SMA is a real world example of an open home automation interoperability specification. SMA is now under consideration by NIST as a potential Smart Grid interoperability standard. SMA is just one example of an open interface that could be adopted by policy makers for Residential Energy Management systems to interconnect with the Smart Grid. It is included here since it is a proven example of a market solution driven by consumer wants and needs.

SMA specifies an application layer protocol that allows automation devices in the home to be controlled by applications running on servers "in the cloud," in industry parlance. It is based on the Representational State Transfer model (or REST), which is the same model used for everyday web browsing, and therefore is supported on almost every network in operation today. Every device in the home has a unique Internet address and name, e.g, www.myhome.com/thermostat, and is controlled by using standard Internet messaging protocols including XML and HTTP, e.g., http://www.myhome.com/asp?set_thermostat=72. Communicating with devices is done using the same session establishment and security commonly used with Internet browsing today. This allows huge scalability and leveraging of existing off-the-shelf networking products today, such as home gateways.

By being always on, always aware, and always connected, such network based applications will quickly become the norm for home energy management, home security, health care monitoring, and home automation.

SMA is based on standard IP and can run on any network; however, there are extensions and optimizations for cable networks. Examples of cable-specific features include QoS controls, physical network management, and end-to-end security. Though the SMA solution was optimized for delivery via a cable plant typically managed by cable operators, it can serve as a model for a solution that can operate on a variety of network platforms and access technologies. The point is simply that a common Smart Home – to - Smart Grid interoperability standard can be readily adapted from a specification such as SMA. This would result in broad buy-in and interoperability by residential energy management players since they could be assured their products and services would connect to any utility in any market.

4 Summary

The need for a robust market for residential energy management is clear. What remains unclear is how the government will allow, even encourage, this market to develop. Without the ability for consumers to choose their own solutions, the ability to read their

own meter directly, and the ability to control their own usage, this market will not reach its potential.

At risk is the success of the Smart Grid in this country. In order to realize the maximum benefits from residential energy management, the federal government must recognize:

1. An open market for residential energy management is required to achieve real interoperability and economies of scale on a national basis. Adopting these principles would ensure the market for home energy management systems and services would be open to all potential entrants.

2. An open market requires that utilities allow direct access to real time meter data and real time pricing and pricing signals. This will prevent the market from being Balkanized into islands of utility-specific solutions.

3. An open market requires competition to stimulate the greatest innovation and greatest investment and maximize the probability of a sustainable market. The rich diversity of solutions that are being developed now and in the future should be allowed to connect to the Smart Grid, as long as they do not harm the grid.

This way, the most innovative and consumer friendly solutions will be given the opportunity to succeed in the marketplace. Arming consumers with powerful, easy to use, compelling energy management solutions, and having them invest in their use, is the only truly sustainable path to meeting our national energy reduction goals in the home.